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09/922,122	08/03/2001	Hugues Marchand	G&C 30794.79-US-U1	7852

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	**PAPER NUMBER**
1722	

DATE MAILED: 07/15/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/922,122	Applicant(s) MARCHAND ET AL.
	Examiner Matthew J. Song	Art Unit 1722

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 May 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-9,11-35 and 38* is/are pending in the application.

4a) Of the above claim(s) *18-34* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-9,11-17,35 and 38* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *5/16/2005*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1-2, 4-9, 15-17, 35, and 38 rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Goetz et al (US 6,441,393).

Goetz et al discloses a light emitting device **10** includes an optional substrate **11** of silicon. Goetz et al also discloses a low temperature buffer layer **2** of GaN or AlN is often disposed on the substrate **11** and a III-V nitride layer **13** made of a doped aluminum gallium nitride or gallium nitride (col 3, ln 20-60). Goetz et al also discloses the composition of the various layers may be smoothly graded over a finite thickness or over the entire thickness of a layer (col 3, ln 60 to col 4, ln 3), this reads on applicants' graded gallium nitride layer on a silicon substrate because Goetz et al discloses grading the composition of a gallium nitride layer on a silicon substrate.

Goetz et al discloses using a silicon substrate can be used and depositing a graded gallium nitride layer can be deposited on a substrate. Goetz et al does not disclose the particular combination of a silicon substrate and graded gallium nitride layer. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Goetz et al by using

a graded gallium nitride buffer layer on a silicon substrate to improve the lattice mismatch between the substrate and a light emitting layer.

Referring to claim 1 and 38, Goetz et al teaches a graded AlGaN layer from an AlN layer to a GaN, but is silent to the graded gallium nitride layer has a net compressive stress. It is inherent to Goetz et al to have a net compressive stress because the differences in lattice constant throughout the graded layer inherently causes compressive stress.

Applicant is reminded that claims 2, 4-9, 16-17, 35 are product by process claims and are not limited to the manipulations of the recited steps, only the structure of the implied steps. Even though the product-by-process claims are limited by and defined by the process, determination of the patentability is based on the product itself. If the product in the product by process claim is the same or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process (MPEP 2113).

Referring to claim 2, 4-9 and 35, the instant claims only further limit the process of the invention.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various

claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1-2, 4-9, 11-17, 35 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Goetz et al (US 6,441,393) in view of Redwing et al (US 5,874,747).

Goetz et al discloses a light emitting device **10** includes an optional substrate **11** of silicon. Goetz et al also discloses a low temperature buffer layer **2** of GaN or AlN is often disposed on the substrate **11** and a III-V nitride layer **13** made of a doped aluminum gallium nitride or gallium nitride (col 3, ln 20-60). Goetz et al also discloses the composition of the various layers may be smoothly graded over a finite thickness or over the entire thickness of a layer (col 3, ln 60 to col 4, ln 3), this reads on applicants' graded gallium nitride layer on a silicon substrate because Goetz et al discloses grading the composition of a gallium nitride layer on a silicon substrate.

Goetz et al discloses using a silicon substrate can be used and depositing a graded gallium nitride layer can be deposited on a substrate. Goetz et al does not disclose the particular combination of a silicon substrate and graded gallium nitride layer. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Goetz et al by using a graded gallium nitride buffer layer on a silicon substrate to improve the lattice mismatch between the substrate and a light emitting layer.

In a method of making a light emitting device, Redwing et al teaches the quality of a GaN layer grown a lattice mismatched substrate such as SiC or Si is greatly improved when a buffer or transition layer is grown on the substrate prior to growth of the GaN layer (col 4, ln 60-65). Redwing et al also teaches a buffer structure which eliminates cracking comprising a compositionally graded (Al,Ga)N buffer layer between a substrate and a GaN epi-layer. Redwing et al also teaches using a graded buffer layer gradually varies the lattice constant and thermal expansion coefficient from that of AlN to that of GaN (col 18, ln 35 to col 19, ln 25).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Goetz et al by using a compositionally graded buffer layer between a silicon substrate and GaN light emitting layer to gradually vary the lattice constant and thermal expansion coefficient of the buffer layer, thereby reducing cracking.

Referring to claim 1, the combination of Goetz et al and Redwing et al teaches a graded AlGaN layer from an AlN layer to a GaN, but is silent to the graded gallium nitride layer has a net compressive stress. It is inherent to the combination of Goetz et al and Redwing et al to have a net compressive stress because the differences in lattice constant throughout the graded layer inherently causes compressive stress.

Applicant is reminded that claims 2, 4-9, 16-17, 35 are product by process claims and are not limited to the manipulations of the recited steps, only the structure of the implied steps. Even though the product-by-process claims are limited by and defined by the process, determination of the patentability is based on the product itself. If the product in the product by process claim is the same or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process (MPEP 2113).

Referring to claim 2, 4-9 and 35, the instant claims only further limit the process of the invention. Edmond et al teaches the structure of instantly claimed product.

Referring to claim 11-14, the combination of Goetz et al and Redwing et al teaches an AlN layer (50% Al) is graded to a GaN layer (0% Al) (col 18, ln 60 to col 19, ln 5). Furthermore, the initial and final concentrations of elements in the graded buffer are known to affect cracking of a layer grown, thereon (col 18, ln 60 to col 19, ln 5). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Goetz et al and Redwing et al by optimizing the initial and final concentrations of the graded buffer layer to produce a crack free GaN epi-layer.

Referring to claim 15, the combination of Goetz et al and Redwing et al teaches depositing a light emitting layer on the buffer layer.

Referring to claim 16-17, the combination of Goetz et al and Redwing et al teaches donor species, such as Si, are introduced simultaneously to stabilize the structural integrity of a heteroepitaxially grown III-V nitride on lattice mismatched substrates (' 393 col 5, ln 30-65).

Referring to claims 38, the combination of Goetz et al and Redwing et al teaches a graded AlGaN layer from an AlN layer to a GaN, as applicant, but is silent to the graded layer has a net stress below a stress required for crack generation. This is inherent to the combination of Goetz et al and Redwing et al because the graded buffer layers are used to grow gallium nitride layers without cracks (''747 col 25, ln 5-20). Furthermore, a doped layer will not crack when grown to a proper thickness, which can be determined by routine experimentation ('393 col 5, ln 35-45 and col 6, ln 1-10).

5. Claims 1-2, 4-9, 11-17, 35 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ishibashi et al (US 5,923,950) in view of Redwing et al (US 5,874,747) or Edmond et al (US 5,739,554).

Ishibashi et al discloses a method of growing a single crystal layer $Al_xGa_{1-x-y}In_yN$ on a SiC substrate and the same effects can be obtained by forming a SiC semiconductor layer by carbonizing the main surface of Si substrate and by forming an AlN buffer layer on the semiconductor layer. Ishibashi et al also discloses this makes it possible to obtain a high quality gallium nitride semiconductor by using a Si semiconductor substrate, which is easily available.

Ishibashi et al does not disclose a graded gallium nitride layer.

Edmond et al discloses a buffer layer **42** can comprise a graded layer of AlGaN that is substantially entirely aluminum nitride where it meets the SiC substrate **42** and then is progressively graded with increasing amounts of gallium until it is substantially entirely gallium nitride at its upper surface where it meets the n-type layer of gallium nitride **43** (Fig 2 and col 7, ln 1-67), this progressively graded layer reads on applicant's varying composition of substantially continuous grade. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Ishibashi et al by using a graded AlGaN buffer layer taught by Edmond et al on the SiC converted Si substrate to gradually reduce the lattice mismatch and thermal expansion coefficient of the substrate and subsequent GaN layer, which reduces cracking and because graded buffer layers are known to be superior to AlN layer ('747 col 18, ln 50 to col 19, ln 10).

Redwing et al discloses a method of forming a graded (Al,Ga)N buffer on a SiC substrate wherein the Al content is graded from AlN at the substrate to GaN at the top, this reads on

applicant's varying composition of a substantially continuous grade. Redwing et al is also discloses an initial TMAl flow rate and a final flow rate were chosen that would give the same growth rate and TMAl flow rate is supplied without interruption (Example V and Fig 20). Redwing et al also discloses the graded layer could also be made of (Al,In)N or (Al,Ga,In)N (col 19, ln 1-67). Redwing et al also discloses a compositionally graded GaN layer may comprise a compositionally graded $Al_xGa_{1-x}N$ buffer layer between gallium nitride and a silicon carbide layer and the buffer layer is compositionally graded from an interface of the buffer layer with a silicon carbide layer at which x is 0 to an interface of the buffer layer with a gallium nitride layer at which x is 1 (col 7, ln 1-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Ishibashi et al by using a graded AlGaN buffer layer taught by Redwing on the SiC converted Si substrate to gradually reduce the lattice mismatch and thermal expansion coefficient of the substrate and subsequent GaN layer, which reduces cracking.

Referring to claim 1, the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al teaches a graded AlGaN layer from an AlN layer to a GaN, but is silent to the graded gallium nitride layer has a net compressive stress. It is inherent to the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al to have a net compressive stress because the differences in lattice constant throughout the graded layer inherently causes compressive stress.

Referring to claim 2, 4-9, 16-17 and 35, the instant claims only further limit the process of the invention. Edmond et al teaches the structure of instantly claimed product.

Referring to claim 11-14, the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al teaches an AlN layer (50% Al) is graded to a GaN layer (0% Al) (col 18, ln 60 to col 19, ln 5). Furthermore, the initial and final concentrations of elements in the graded buffer are known to affect cracking of a layer grown, thereon (col 18, ln 60 to col 19, ln 5). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al by optimizing the initial and final concentrations of the graded buffer layer to produce a crack free GaN epi-layer to obtain the claimed ranges.

Referring to claim 15, the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al teaches depositing a light emitting layer on the buffer layer.

Referring to claim 16-17, the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al teaches graded buffer layers of (Al, Ga, In)N ('747 col 19, ln 60-65 and) , this reads on applicants' other element of indium.

Referring to claims 38, the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al teaches a graded AlGaN layer from an AlN layer to a GaN, as applicant, but is silent to the graded layer has a net stress below a stress required for crack generation. This is inherent to the combination of Ishibashi et al and Redwing et al or the combination of Ishibashi et al and Edmond et al because the graded buffer layers are used to grow gallium nitride layers without cracks (''747 col 25, ln 5-20). Furthermore, a doped

layer will not crack when grown to a proper thickness, which can be determined by routine experimentation ('393 col 5, ln 35-45 and col 6, ln 1-10).

Response to Arguments

6. Applicant's arguments filed 5/16/2005 have been fully considered but they are not persuasive.

Applicant's argument that a net compressive stress is not inherent is noted but is not found persuasive. The prior art teaches a similar structure of a silicon substrate and a graded gallium nitride layer, as applicant. The Examiner maintains that the differences in lattice constant of the substrate and gallium nitride layer necessarily result in stress. The Examiner has provided reasoning tending to show inherency; therefore the burden shifts to applicant to show an unobvious difference (MPEP 2112). Applicants have merely alleged that a net compressive stress **may** not occur because stress is determined by multiple variables, such as lattice constant difference and thermal expansion mismatch. However, this argument is not persuasive because the same material will have the same thermal properties as well. Therefore, by forming the GaN layer on a similar substrate which will require heating and cooling, the thermal stresses are expected to be the same for the product claimed by applicant and the product taught by the prior art. Since net compressive stress is the sum of thermal and lattice stresses (pg 8 of the specification), the GaN graded layer and Si substrate will inherently have a net compressive stress. Applicants have not provided persuasive evidence that the prior art would not have resulted in a structure with a net compressive stress since the prior art teaches forming a similar

structure using conventional deposition techniques, which would require heating and cooling resulting in similar lattice and thermal stresses, as applicant.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Yoshida (US 5,496,767) teaches a compressive stress is applied to an active layer by a strain due to a difference between lattice constants of the active layer to a substrate (col 1).

Kamiyama et al (US 6,324,200) teaches adding arsenic to the composition of a Group III-V nitride semiconductor results in a shallower acceptor level, as compared to nitride semiconductors without added Arsenic (col 10, ln 1-67).

Okumura (EP 1 022 825 A1) teaches a SiC substrate or a Si substrate and a buffer layer of GaN or a ternary mixed crystal may be deposited thereon ([0057]).

Weeks, JR et al (US 2002/0074552) claims a similar product as instantly claimed by applicant, note claims 1-53.

Solomon (US 6,146,457) teaches a Si substrate is chosen for the deposition of GaN because it can easily be manufactured to very small thicknesses (col 6, ln 35-45).

Hirosawa et al ("Growth of single crystal $Al_xGa_{1-x}N$ Films on Si Substrates by Metalorganic Vapor Phase Epitaxy) teaches a Si substrate is used for the deposition of $Al_xGa_{1-x}N$ films because Si substrates are of high quality, large size and low cost (Introduction).

8. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on 571-272-1166. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1722

MJS
July 10, 2005

ROBERT KUNEMUND
PRIMARY EXAMINER